ACS

Adaptive Computing Systems

Dr. José L. Muñoz

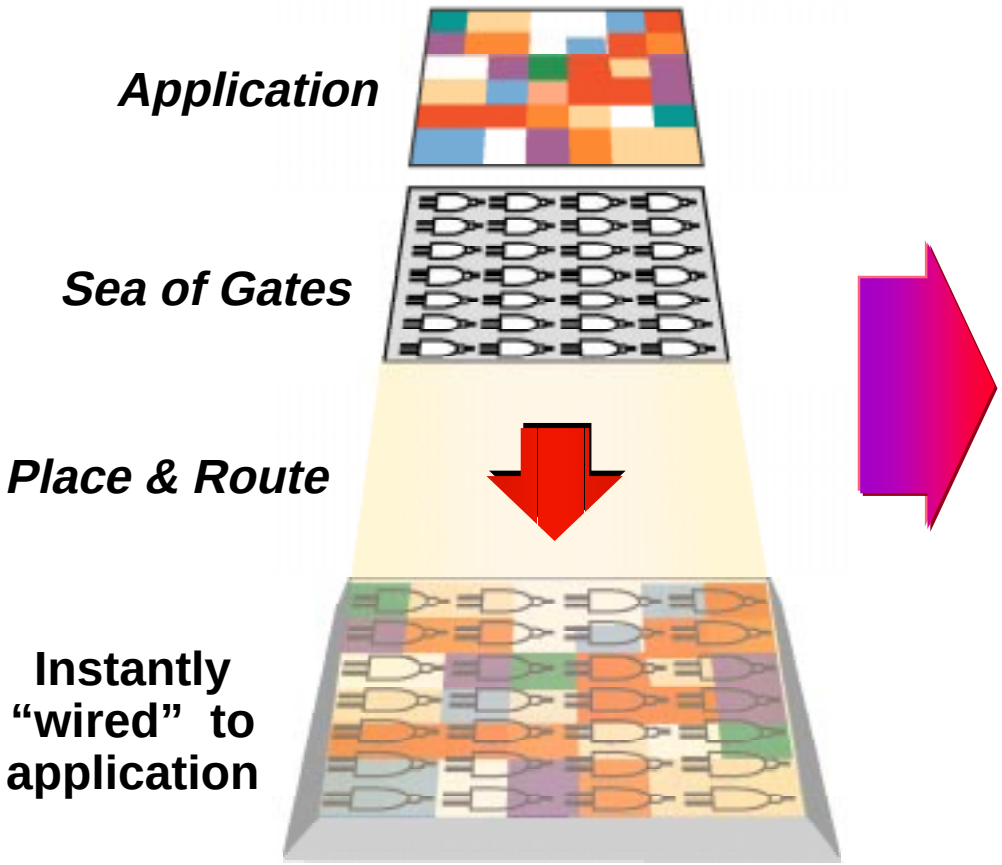
DARPA/ITO

May 1998

Situation Today...

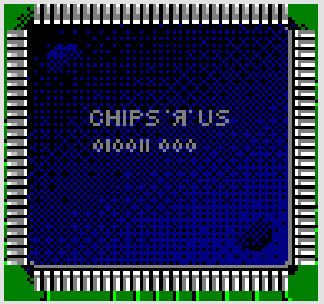
Architecture is already provided… software must do the best it can within those given constraints

ACS: Vision



Application-Enabled Configurable Computer

- Commodity technology dynamically specialized
- Life cycle performance upgrades
- Adapt to new threats
- Extend mission capabilities



Adaptive Computing Systems

"The microchip that rewires itself"

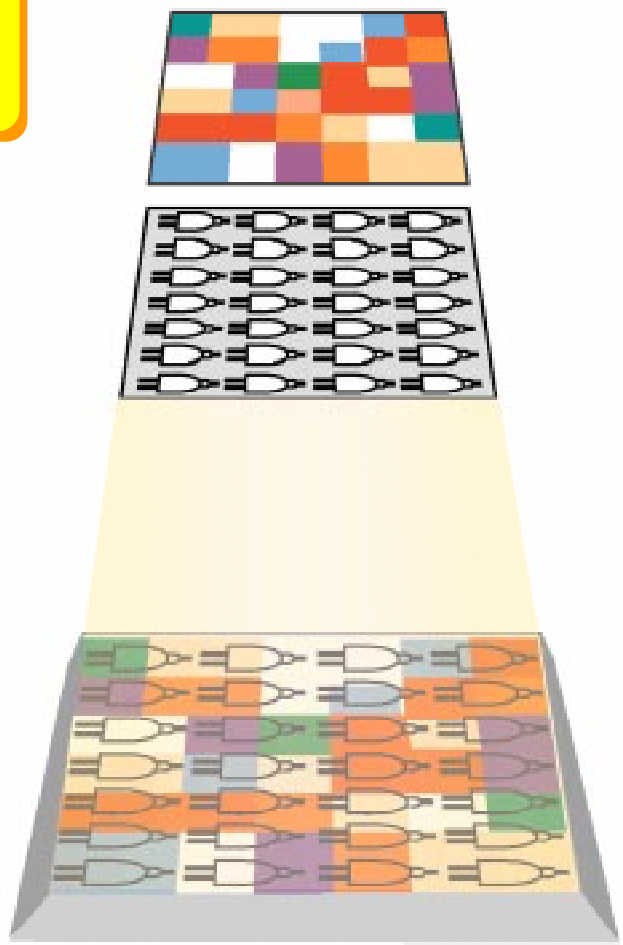
June 1997

"Computers that modify their hardware circuits as they operate are opening a new era in computer design. Because they can filter data rapidly, they excel at pattern recognition, image processing and encryption"

Goals

Performance benefits of Hardware with the flexibility of Software

Sample ACS Challenge problem: ATR/ 1 cu.ft. 500X better



100X - 1000X Performance improvement over micro-processor based systems

Defense testbeds: ACS Challenge Problems

Temporal re-use: Dynamic adaptation at runtime

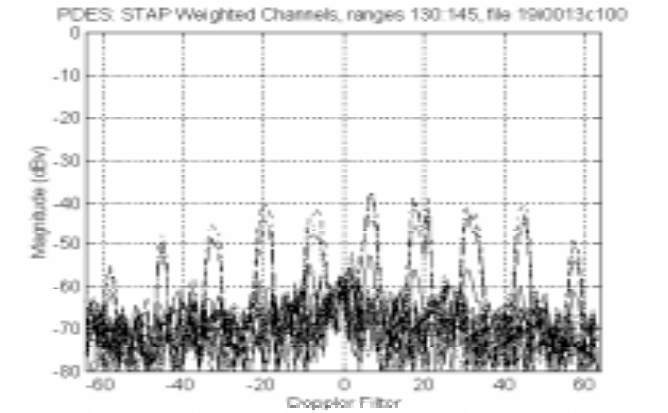
Power/area efficiency

Domain specific development environments

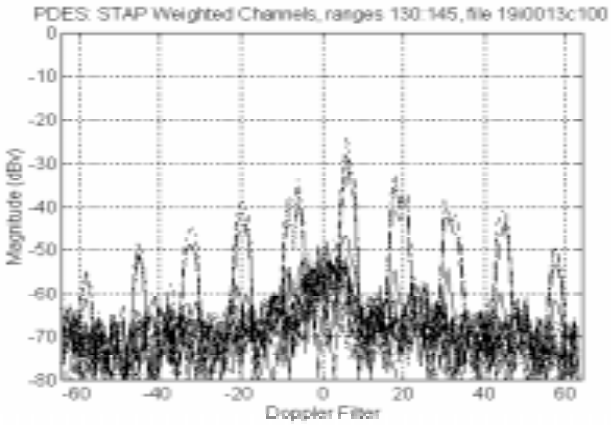
Sample ACS Benefit: Custom Precision Arithmetic

Current DSP Device Technology	DSP Chips Only	DSP With Micro-Accel
SHARC Chips Micro-Accelerators	603 0	46 8

1999 DSP Device Technology	Next Gen DSP Chips Only	Next Gen DSP With Micro-Accel
HH SHARC Chips Micro-Accelerators	242 0	18 8



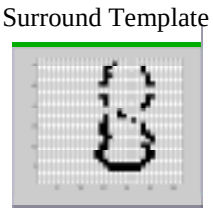
Beamforming with STAP*
8-bit Mantissa Floating Point Arithmetic

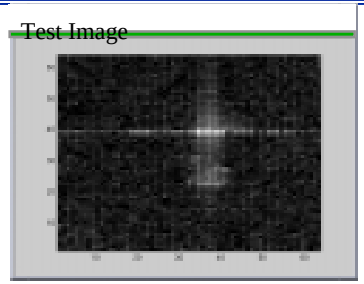


Beamforming with STAP*
4-bit Mantissa Floating Point Arithmetic

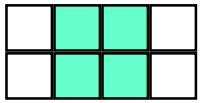
*** 32 Range Gates Used for Weight Generation**

Sample ACS Benefit: ATR Template Matching

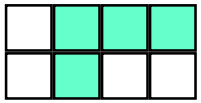


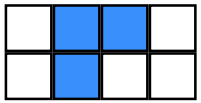


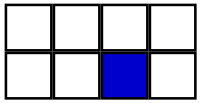
Template A

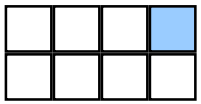


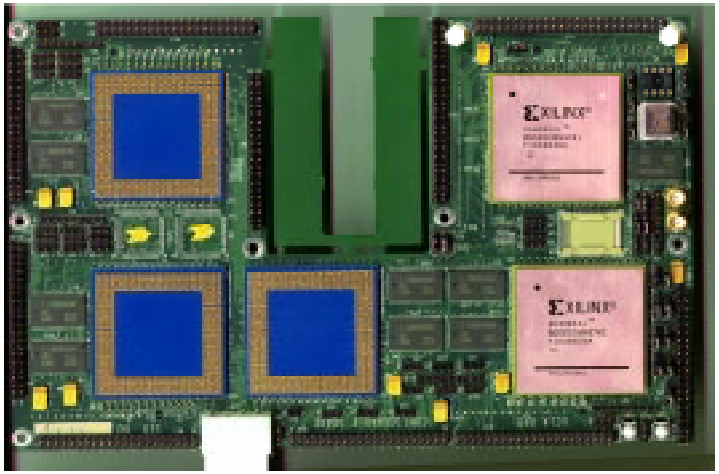
Template B



Zone 1  **Common to A/B**

Zone 2  **Unique to Template A**

Zone 3  **Unique to Template B**



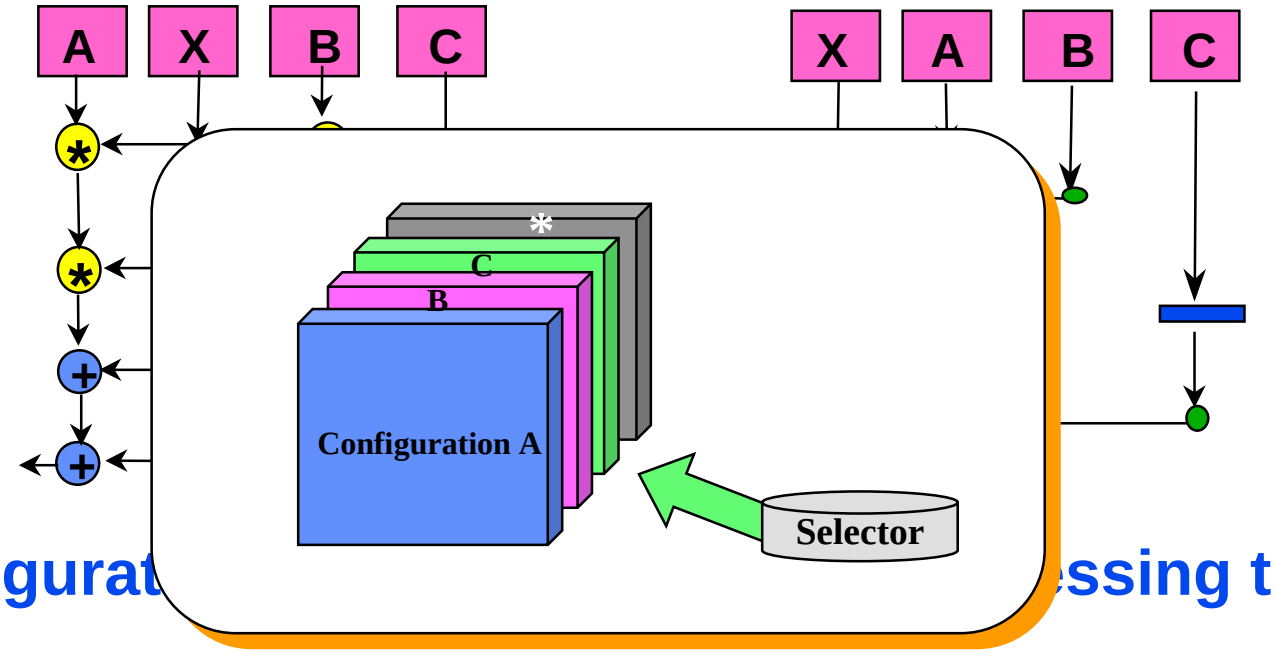
UCLA PCI/Myrinet board

Template additions:

Template A = Zone 1 + Zone 2

Template B = Zone 1 + Zone 3

Key challenge: Reconfiguration Time

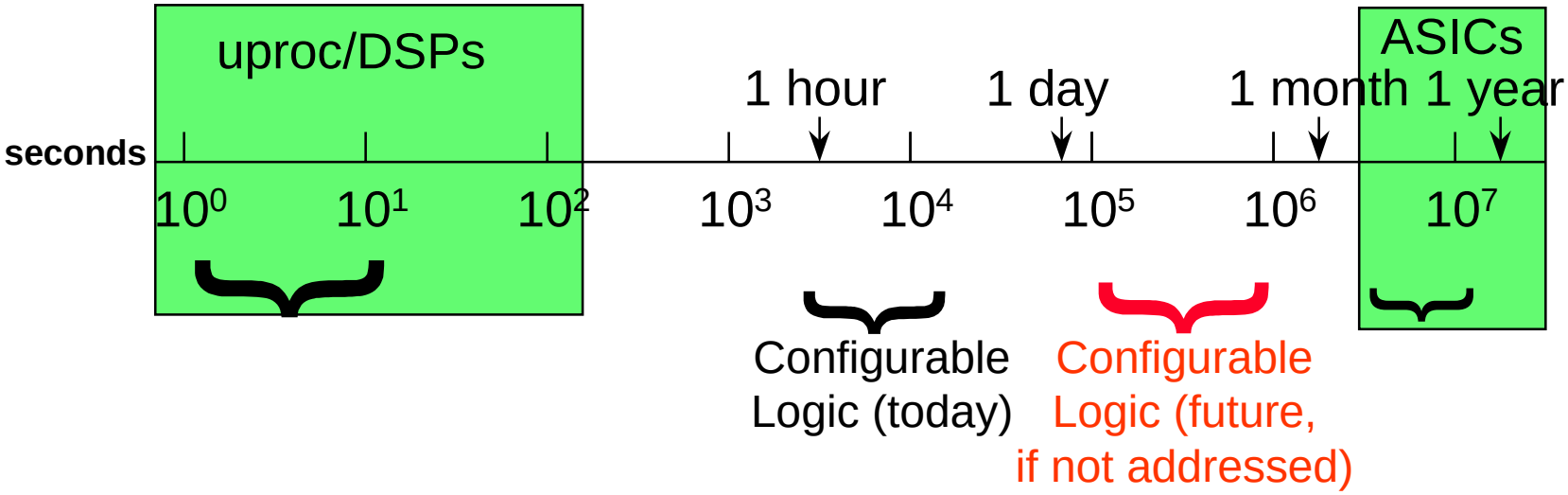


Reconfigurat essing time.

Current reconfiguration times measured in msec are unacceptable for many applications… need nsec…
3 ORDERS OF MAGNITUDE IMPROVEMENT

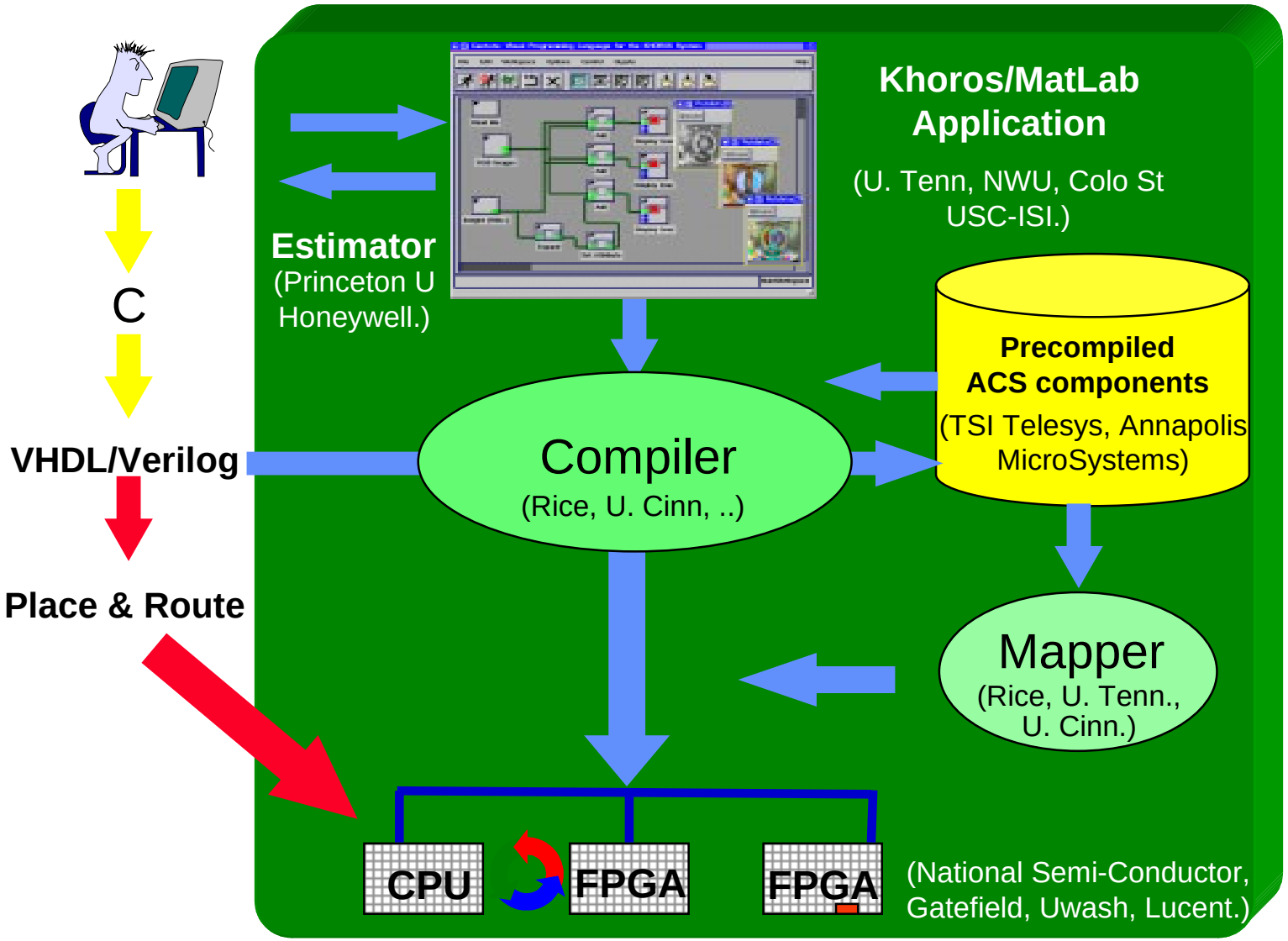
Key Challenge: Compilation times

- From a high level language description to a working implementation
  - includes “place and route” times



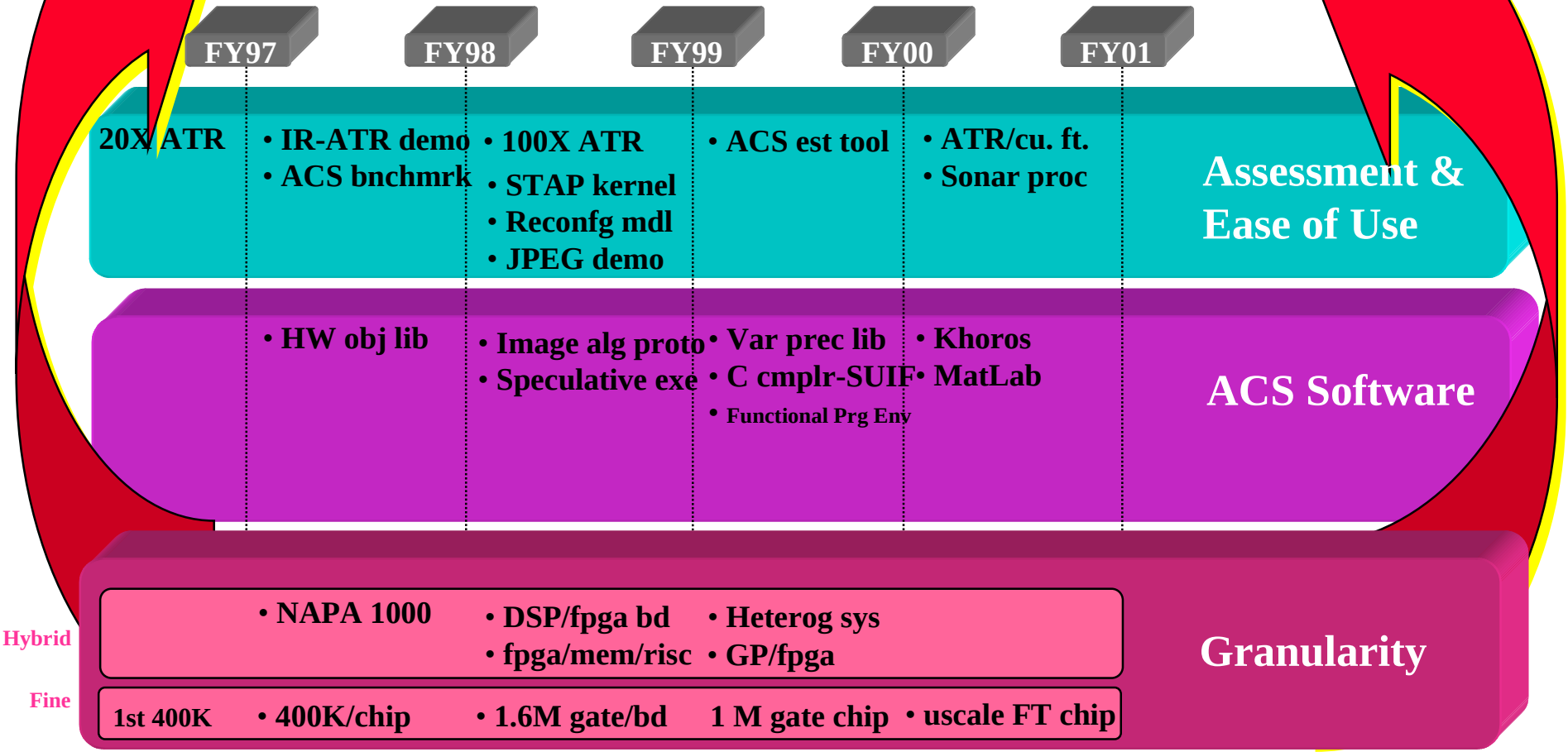
4 orders of magnitude speedups are required in this area

ACS Design Flow

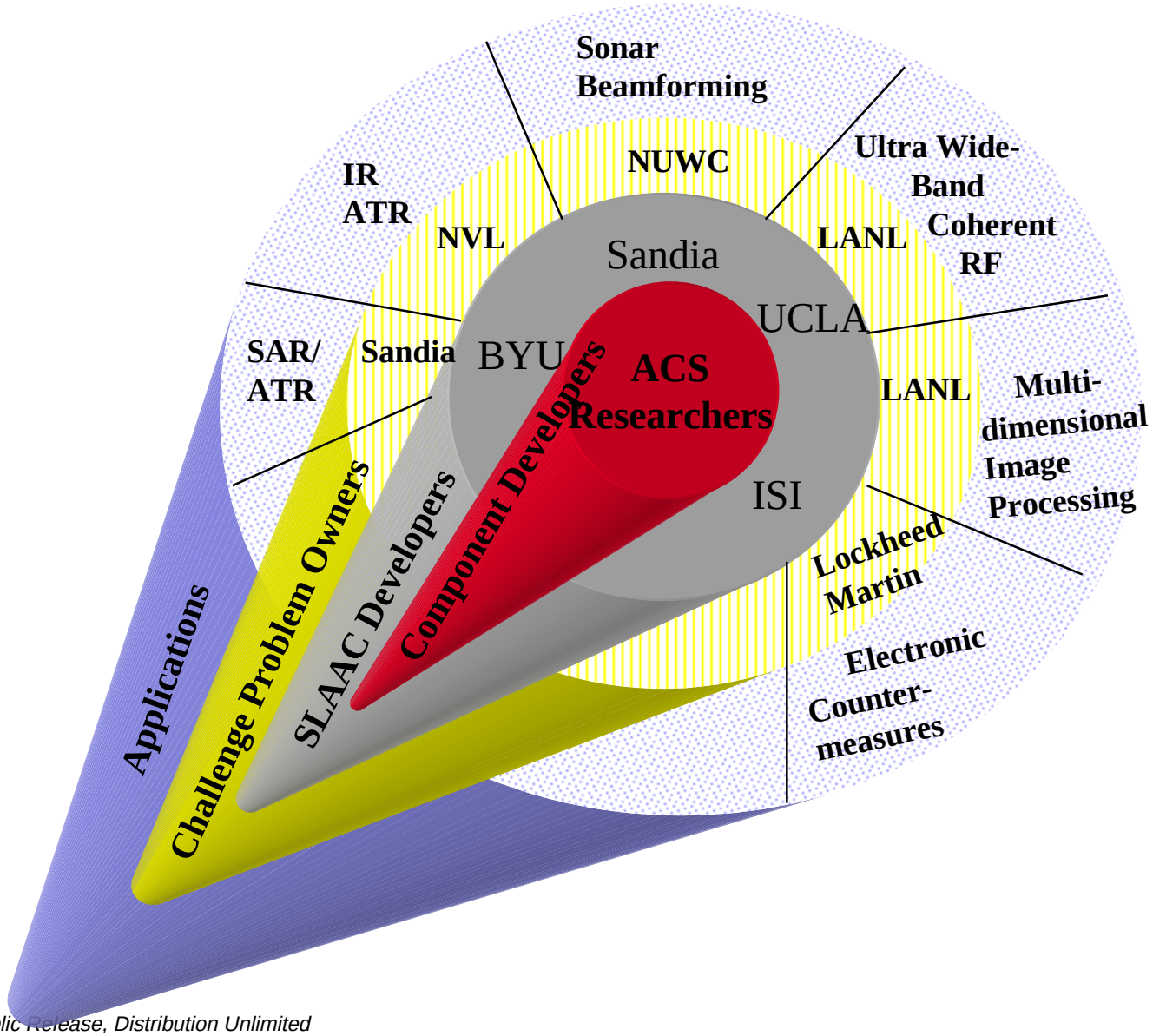


Roadmap

Defense testbeds
Variable precision arithmetic
Multimode adaptive radio
Runtime adaption
M gates/chip
ATR in 1 cu. ft.
Fault tolerance
Point-of-use encryption
Challenge problems
Sonar: adaptive beamforming



Insertion Opportunities



Surveillance Challenge Problem

Problem - SAR / ATR

40,000 sqnm / day @ 1 ft. Resolution

*Corresponds to a data rate of 40 Megapixels / sec

System Parameter	Current	Challenge	Scale Factor
SAR Area Coverage Rate (sqnm / day @1 ft Res.)	1000	40,000*	40X (FOA, Indexer, Ident.)
Number of Target Classes	6	30	5X (Indexer, Ident.)
Level / Difficulty of CC&D	Low	High	100X (Indexer) 10X (Ident.)

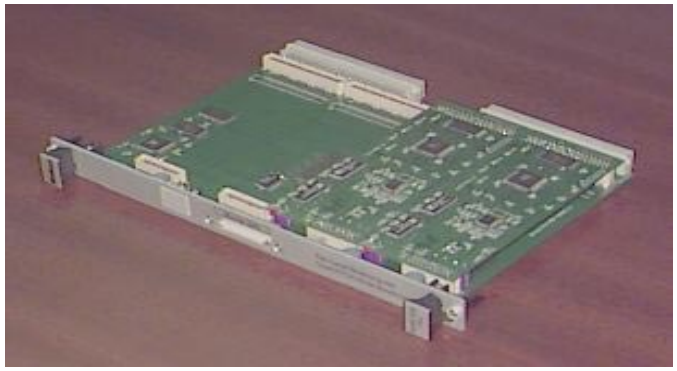
4 Orders of Magnitude problem scale…
in 1 Order of Magnitude smaller volume!!

Surveillance Challenge

Circa 1997

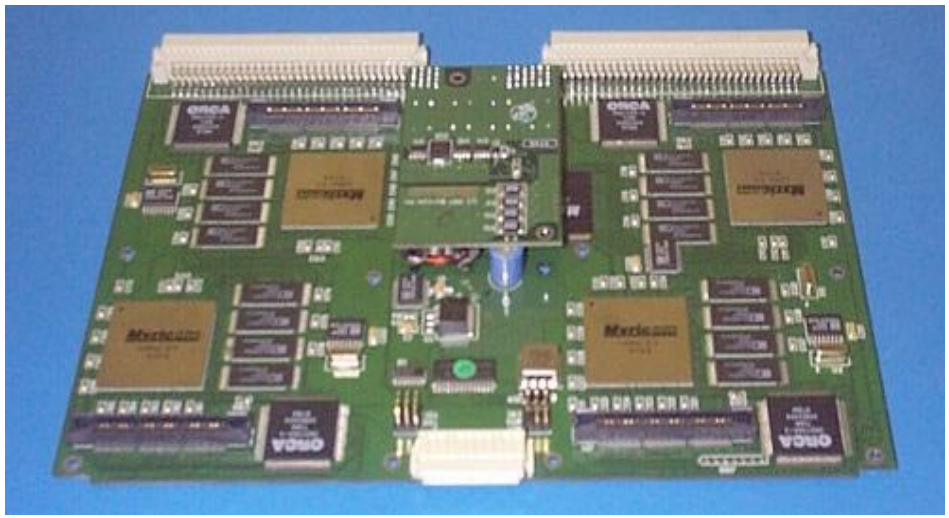
JSTARS SAR ATR Processor

Circa 1998



ORCA based two-level board

Circa 2000 . . . Network Enabled



ACS Challenge Problems

- Surveillance Challenge Problem (Sandia National Lab)
- IR Automatic Target Recognition: Tank Application (Night Vision Lab)
- Sonar Adaptiv[illegible] Warfare Center)
- [illegible])
- [illegible]
- Fault-tolerant/Low p[illegible] (JPL)
- RF Transient Signal Analysis (Los Alamos National Lab)
- Plume Detection and Laser Spectral Analysis (LANL)

Performance benefits of Hardware…
Flexibility of Software

www.ito.arpa.mil/ResearchAreas96/AdaptiveComputingSys.html